Research Product

Recommendations for Planning and Conducting Multi-Service Tactical Training With Distributed Interactive Simulation Technology

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A Four-Service Project

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14. ABSTRACT *(Maximum 200 words)*:

This report recommends practices for planning and conducting tactical training using Distributed Interactive Simulation (DIS) technology with multi-Service groups. Groups are geographically separated. The recommendations presented are based on the experience gained from the Multi-Service Distributed Training Testbed (MDT2) -- a testbed designed to develop training opportunities and tools to increase the utility of multi-Service training. MDT2 is a realistic, although synthetic, environment for training with the flexibility to support planning, preparation, execution, and feedback for the multi-Service Close Air Support (CAS) mission. This report combines the knowledge from MDT2-CAS with the authors' knowledge of training into recommendations about how to train best with DIS technology.

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Research Product

Recommendations for Planning and Conducting Multi-Service Tactical Training with Distributed Interactive Simulation Technology[1]

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These recommendations are based on lessons learned from developmental exercises using Distributed Interactive Simulation (DIS) technologies to train Close Air Support (CAS) combat operations in the Multi-Service Distributed Training Testbed (MDT2). They are written to help senior managers plan and use DIS technology for prototype unit training applications. Detailed appendixes referred to in this report describe the tools and methods used specifically for training CAS and are available from the Defense Technical Information Center.

The MDT2 program is a complex of interrelated projects designed to develop and evaluate DIS-based training technologies and methods to meet Multi-Service training needs. Its advocates and sponsors include (1) the Defense Modeling and Simulation Office (DMSO), (2) the Office of the Under Secretary of Defense (Personnel and Readiness) - Defense Manpower Data Center's (DMDC) Training Readiness Evaluation and Analysis Division (formerly DITRA), and (3) the four military Services. Thanks are extended to the many Government, military, civilian, and contractor organizations who made the effort possible. The principal agencies and laboratories who supported the project are:

- Director Defense Research and Engineering/
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- Office of the Under Secretary of Defense/
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- U.S. Army Training and Doctrine Command/
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- Naval Air Warfare Center
  -- Training Systems Division (NAWCTSD) - formerly NTSC
  -- Aircraft Division (NAWCAD)

- Marine Corps Combat Development Command (MCCDC)

- Air Force Armstrong Laboratory/Aircrew Training
  Research Division (AL/HRA)

- Trainers and Warriors (Active, Reserve, & National Guard)

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Recommendations for Planning and Conducting Multi-Service Tactical Training with Distributed Interactive Simulation (DIS) Technology

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Recommendations for Planning and Conducting Multi-Service Tactical Training with Distributed Interactive Simulation (DIS) Technology

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[2] Appendixes contain over 200 pages of detailed forms and formats used for training multi-Service Close Air Support. They are packaged separately (RN 97-04) and available from Defense Technical Information Center, Reference Desk, 8725 John J. Kingman Road, Suite 0944, Fort Belvoir, VA 22060-6218 (Telephone: (703) 767-8274; DSN 427-8274).

Recommendations for Planning and Conducting Multi-Service Tactical Training with Distributed Interactive Simulation (DIS) Technology

1.0   INTRODUCTION

The conduct of group or unit training for combat historically involves military exercises in field settings. Such exercises are costly, potentially dangerous, and damaging to the environment. There also are major limitations on what can be trained in field exercises. The use of Distributed Interactive Simulation (DIS) technology provides a way for units at different sites to prepare for or to supplement field training experience. This paper recommends practices for planning and conducting tactical training using DIS technology with multi-Service[3] groups even though they are geographically separated.

DIS technology uses wide area communication networks to link different simulators at separate locations. This capability can be valuable for single-Service tactical training but, in addition, it presents opportunities for multi-Service combat mission training. Many multi-Service missions may benefit from such training--for example, air defense, tactical air-to-air combat, combined amphibious and land assault, and fire support including Close Air Support (CAS). There also are many uses for operations other than war, such as teams and units (a) fighting large fires; (b) training disaster relief, including fire and rescue, police, and medical units; and (c) managing emergencies with multi-disciplinary units in cities and at airports as a general case.

The Multi-Service Distributed Training Testbed (MDT2) program is designed to develop training opportunities and tools that will increase the utility of multi-Service training. The testbed provides a realistic, although synthetic, environment for training and the flexibility to support planning, preparation, execution, and feedback. Its first application was to the multi-Service CAS mission. The recommendations presented in this paper are based on the experience gained from that application.

Both live and virtual (simulated) environments have training advantages which neither alone can provide equally well today. The live setting offers realistic, hands-on, fatiguing training, but it rarely provides unrestricted employment of weapon systems. The virtual setting lacks realism in other ways, because of simulator limitations, but it allows training in activities and procedures that are difficult or impossible to train in live environments. In addition, a major advantage of training in virtual environments is that such exercises may more easily be tailored than live exercises to specific needs of multi-Service teams and groups.

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[3]Multi-Service refers to more than one military Service working together for combat operations but not dependent on a Joint Commander. Joint Operations are those conducted by more than one Service under a Joint Commander.

1.1 The Goal: Better Multi-Service Training

1.1.1 Purposes of MDT2

The MDT2 program is designed to facilitate DIS-based training. The testbed begins the process of designing and assessing prototype training methods and tools to enhance distributed training. Recommendations about these prototypes form the major portion of this paper and provide a starting point for addressing the following training needs:

(1) Effective use of distributed training. What skills are best trained (and how well) using DIS? How can DIS technology best be incorporated into a program for combat mission training? Other topics include how to portray battlefield synchronization, how to determine feedback effectiveness, and the identification of training challenges.

(2) Tools for multi-Service training feedback or After-Action Review (AAR). What different measurements and types of feedback are useful for assessing collective performance? What combinations of tools and methods for viewing and interpreting events (e.g., "bird's-eye views," combat process and outcome measures) are most meaningful?

(3) A training program using existing DIS technologies. The MDT2-DIS environment needs an open system architecture and accepted conventions for interoperability to accommodate changes needed to improve training. Costs and effectiveness must be estimated to determine the value of such training.

Overall, MDT2 addresses the need to integrate training methods and tools with successful engineering of a DIS network in order to provide significant training utility.

1.1.2 Purposes of MDT2-CAS

The MDT2-CAS project was the first one performed in a multi-Service testbed that sought to determine what training and feedback works well, what does not, and what needs to be improved to take best advantage of the technology. It investigated a schema for best use of DIS technology to provide practical and cost-effective home station training in addition to field exercises. Except for a few feasibility demonstrations, the application of DIS technology to training across the military Services is new.

Specifically, the project objectives for MDT2-CAS were (a) to develop recommendations for preparing training objectives and designing performance measures for multi-Service CAS, and (b) to demonstrate the value of using DIS technology for CAS training. "Lessons learned" from this experience provide the basis for these recommendations and their use for other types of training in multi-Service tactical operations.

During its first 2 years, MDT2 showed the feasibility of using DIS technology to train multi-Service CAS combat operations. CAS operations were trained and that training was documented with measures of performance. The project accomplishments included development of a testbed including (a) training objectives and scenarios for CAS, (b) a distributed network to

conduct such training, and (c) tools and methods to measure performance and provide training feedback.

1.2 Background

1.2.1 Principles of Distributed Interactive Simulation (DIS)

No single simulation site had the numbers and types of simulators needed to support the multi-Service training objectives of MDT2. Therefore, simulators at different sites across the United States were linked with one another to provide the real-time interactive capability needed for MDT2. This allowed ground and air participants from different sites to interact with one another for planning and executing simulated combat missions as part of a warfighting team.

DIS technology provided the means for linking the different simulators used in MDT2. DIS allows real-time interaction between simulators regardless of whether these simulators are in adjacent rooms or thousands of miles apart.

A DIS-based exercise relies on a network of simulations and simulators (manned, computer-generated, or both) as well as supporting computer and communication technologies. It represents an extension of the Simulator Networking (SIMNET) program developed by the Defense Advanced Research Projects Agency.[4] DIS relies on the following principles greatly simplified from more detailed documents:[5]

(1) There is no central computer that tells each simulator how its actions influence others.

(2) Each simulator broadcasts its state (e.g., dead or alive), and changes in its location, movement, and action to other simulators using standardized protocols. Receiving simulators detect broadcast information and calculate how it affects them.

(3) Each simulator establishes or dead-reckons the position of other simulators. Each simulator maintains a dead-reckoning model of other simulators and regularly compares its actual state/position with that model. Whenever a significant difference exists, the simulator broadcasts update information.

(4) Each simulator creates an appropriate virtual world based on the information received from other simulators and its own stored information. Each simulator depicts its virtual world, using its unique simulator technologies (e.g., computer image generation, display, communication, and computers).

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[4] Alluisi, E. A. (1991). The development of technology for collective training: SIMNET, a case history. *Human Factors, 33,* 343-362.

[5] Institute for Simulation and Training, University of Central Florida (1994). *Standard for Distributed Interactive Simulation -- Application Protocols, Version 2.0 Fourth Draft (Revised),* Orlando, FL: Author.

1.2.2 Overview of the MDT2-CAS Program

Connecting the simulators of various Armed Services over a distributed interactive network allows personnel at widely diverse locations to train together on certain tactics, techniques, and procedures (TTP) without leaving home station. Training the TTP for CAS was chosen for the initial MDT2 training exercises because CAS can involve all four Services, and each Service has simulators that replicate combat environments for CAS. In addition, CAS operations are extremely difficult to train in any environment other than DIS.

There were two sets of MDT2-CAS training exercises, one in May 1994 and one in February 1995, which linked simulations and simulators of three Services over the Defense Simulation Internet (DSINet) and one additional T-1 (56Kb) telephone line. Air Force pilots at Armstrong Laboratory, Mesa, AZ (formerly Williams Air Force Base), and Marine Corps pilots at the Air Combat Environment Test and Engineering Facilities of the Naval Air Warfare Center Aircraft Division (NAWCAD), Patuxent River, MD, flew simulators that emulated attack and forward air control aircraft. They supported the conduct of ground force operations by Army units and Air Force liaison elements in vehicle simulators and a Tactical Operations Center (TOC) at the Mounted Warfare Test Bed (MWTB), Fort Knox, KY. In addition, a Marine ground laser designator team served as a ground Forward Air Controller (FAC) and target designator using the Deployed Forward Observer/ Modular Universal Laser Equipment (DFO/MULE) simulator located in May 1994 at San Diego, CA and in February 1995 at Mesa, AZ. VIPs observed the exercise at the sites or at a special monitoring facility at the Institute for Defense Analyses (IDA), Alexandria, VA. The total number of trainees from the Services in each of the MDT2-CAS exercises was 19. (There were also 14 drivers and gunners for the Abrams tank and Bradley infantry vehicle simulators at Fort Knox, who participated in the exercises but whose performance was not crucial for training CAS.) Figure 1 shows the MDT2-CAS Training Exercise configuration for February 1995.
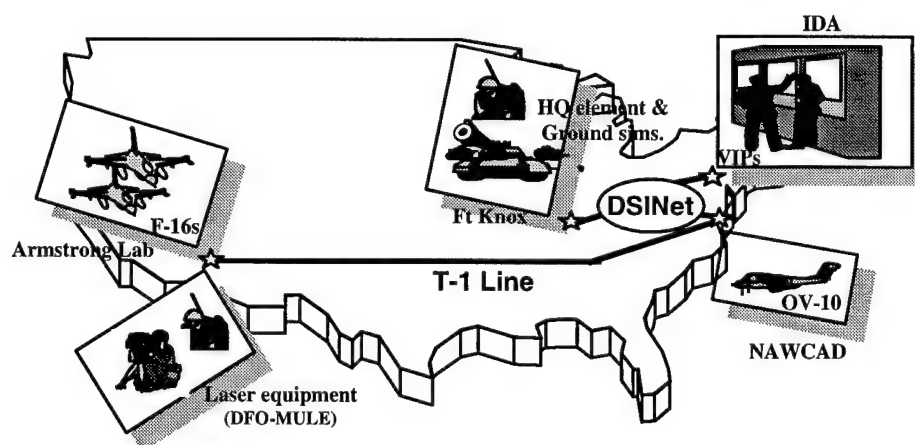
Figure 1. Multi-Service Distributed Training Testbed for Close Air Support.

The training exercise was conducted over a 5-day period including multiple battles and feedback about performance. On the first day, all trainees were briefed, received familiarization training in their simulators, and participated in an offensive battle against semiautomated forces (SAFOR) controlled by subject matter experts (SMEs). Over the succeeding 4 days, two defensive battles and two offensive battles, one per day, were conducted.

During each battle, data about battle procedures and outcomes were collected to support a multi-Service After Action Review (AAR) to give trainees feedback on their performance. Data were obtained in two ways: (1) CAS experts used checklists and rating forms to assess combat procedures, and (2) electronic systems recorded performance and outcomes. These performance assessment methodologies and resulting recommendations are presented later in greater detail (Section 2.4.2). After the battle, an AAR was conducted.

Each evening and the following morning, trainees developed plans and operations orders for the upcoming battle. The battle was then conducted, an AAR was held, and preparations were made for the next battle. Performance improved with each battle in each of the key training objectives for the exercise.

1.3 Presentation of the Recommendations

The following four sections recommend practices for planning and conducting multi-Service training and for developing a prototype training program using DIS technology. The recommendations are drawn from experience gained in MDT2-CAS combined with extensive prior R&D about training. The final section outlines a full set of steps that can be used for planning and coordinating this kind of exercise.

2.0 DESIGNING AND PLANNING THE TRAINING EXERCISE

2.1 Development of a Project Baseline

> **Recommendation: A project plan integrating training requirements with engineering should be developed for all participants to use as a baseline.**

The program director produces a plan that includes both training and engineering requirements following recommendations in subsequent sections of this report. This plan should cover exercise objectives, mission scenarios, and functional requirements. It becomes the reference document for all subsequent development and implementation. Undoubtedly, this plan will change as the training objectives and data requirements mature and as simulation components are modified. These changes need to be understood by the trainers, SMEs, and engineers, with plan revisions published as necessary to keep everyone informed.

2.2 When to Use a DIS Environment for Tactical Training

The reasons to use DIS technology for training are closely related to those for individual simulators. The recommendations that follow were derived from surveys and interviews with MDT2-CAS participants, requirements for training CAS, and observations by the authors of this report. The first recommendation deals with the purpose and training features of a DIS environment; the second suggests when not to use DIS for training.

Recommendation: The use of a DIS environment for training crews, groups, teams, and units should be considered:

Purpose

- **To train coordination and synchronization such as planning and executing a multi-Service CAS mission.**

- **To prepare for other training, such as for the National Training Center (NTC) field exercises or for Air Warrior.**

- **To do part-mission training, such as coordinating CAS pilots with forward air controllers.**

- **To conduct training otherwise restricted by security, safety, environment, or weather.**

Training Features

- **When the operation being trained would benefit from weapons' effects in more realistic time and spatial relationships to enemy and friendly forces.**

- **When real-time kill removal and casualty assessment would enhance learning.**

- **When situation awareness training is desirable for how and when fratricide occurs.**

- **When the greatly improved feedback of DIS environments compared to others is desired for participants.**

- **When high training efficiency (a high rate of tasks/events trained in a short amount of time) is desired.**

Recommendation: The use of DIS for multi-Service applications should not be considered to:

- **Train Service-specific tasks.**

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- **Replace field/command post exercises.**

2.3 Participants and Objectives for DIS Training Development

2.3.1 Responsibilities

Recommendation: A multidisciplinary team should be set up to support the formulation and development of a DIS-based training program.

This team should include training developers, human performance experts, network engineers, site representatives, SMEs, observer/controllers (O/Cs), and representatives of the training audience. Throughout the program development process, specialists must regularly interact to ensure that development of the entire system and its operation is according to plans. For example, early program decisions should be based on input from training developers on training requirements and from engineers on technologies available to support training.

Moreover, DIS technology must be assessed at each stage of development because there are likely to be constraints on what can be accomplished that were not recognized at the outset. Engineers using a prototypical training scenario can determine which training tasks may be supported fully and reliably by the available simulators. Engineers and other site representatives can provide input about site capabilities and limitations relative to the tasks to be trained, and on whether intersite communications are adequate for exercise control, assessment, and feedback.

Recommendation: Technical specialists should be identified as primary points-of-contact for various phases of exercise planning and execution. Responsibilities and authority should be defined and reporting procedures established.

A DIS exercise hinges on the integrated efforts of several different teams. The typical program director does not have enough time and technical knowledge to successfully manage these teams. Therefore, technical focal points are needed to coordinate related sets of activities such as enhancing simulators or developing training materials. Primary and backup contacts should be identified at each site to coordinate site preparation and participation; in addition, a single point-of-contact at each site must handle network scheduling, system testing, and exercise control. Preparations involve many different government organizations and their supporting contractors. Special procedures must be established for tasking work among organizations and for reporting progress in terms of schedules, technical performance, and budgets.

Each organization involved in the MDT2-CAS program had primary responsibility for selected aspects of the exercise and its preparation. The Air Force had primary responsibility for network engineering: system integration, network scheduling, and system testing. The Army had responsibility for training exercises: scenario development, exercise conduct, and post-exercise review of the training system's quality. The Navy had responsibility for training assessment: trainee performance measurement and analysis. A program director had sole responsibility for monitoring all work and budgets.

2.3.2 Goals, Tasks and Training Objectives

Recommendation: Exercise goals should be specified including who will be trained for what purpose.

Commanders of Army and Air Force elements scheduled for cooperative field exercises may decide to prepare using simulator training for relevant staff and pilots. The result will be better coordination of CAS planning and execution to integrate with other combat assets in the field.

Recommendation: Exercise planners should ensure that multi-Service elements are proficient in individual and Service-specific skills.

Inter-Service and group training should be scheduled after trainees have gained some level of proficiency with individual skills. Observations during MDT2-CAS exercises supplemented by other experience with training crews and groups indicate that such training suffers when individual skills are deficient. MDT2-CAS used trainees who had CAS planning and execution skills in their own Services, but most had very limited experience in multi-Service operations since opportunities for that kind of activity are rare.

Recommendation: Identify tasks that focus on interactions across Services early in exercise planning.

A primary driver for developing DIS technology is that it provides opportunities to practice "warfighting skills;" that is, skills that go beyond basic tactics and use of equipment in multi-Service and combined force operations. Early selection is essential because these tasks are the foundation for developing training objectives, exercise/scenario content, performance measures, and methods for feedback.

Recommendation: Training objectives should be selected or developed.

Training objectives clarify the types of tasks to be trained. A comprehensive set of objectives listed later in this document was developed for CAS multi-Service training at the Army battalion level. At the present time, there are no approved, detailed, and measurable training objectives available for multi-Service missions.

Recommendation: Based on the training objectives, a comprehensive task analysis should be performed and the tasks where two or more Services have to coordinate or cooperate should be listed.

Starting from scratch with no existing training objectives is somewhat daunting. The way to begin is by using "doctrinally correct" TTPs as a basis for developing training objectives. Build a list of critical events and tasks that would be expected during the course of an operation and use this to put together a preliminary set of training objectives.

To determine the basic list of critical events and tasks, it is essential that experienced SMEs conduct a thorough review of existing doctrine and TTP (Service, multi-Service, and Joint). The product of this review should be a list of events with standards of effective performance for each one. For MDT2-CAS, the review produced a comprehensive list of critical events/tasks at Service interfaces, in question-and-answer format. The questions asked who the participants were and what must occur among them to ensure doctrinally correct operations.

The focus on CAS led to the development of 25 training objectives (Figure 2). These were used to develop relevant scenarios and performance measurement tools. They drove the AAR content and format that identified multi-Service performance strengths and weaknesses relative to each training objective. Figure 3 shows an expanded training objective which includes players, conditions, actions, and outcomes. The complete set is in Appendix A.

Recommendation: Materials prepared to this point should be double checked for correctness with Service doctrinal specialists and commands. The final training objectives can then be written.

For CAS, the relevant review agencies were the Air-Land-Sea Application Center (ALSA), Langley, VA and the Air-Ground Operations School (AGOS), Hurlburt Field, FL. Upon receipt of their comments, the final list of 25 training objectives was refined--each with a description of the objective, the key players involved with that objective at that interface, the conditions for performing the objective, the correct actions required, the desired behavioral outcome or product resulting from those actions, and the doctrinal references involved. The next step was for experts to prioritize the training objectives to insure effective use of exercise time and that AARs focus on key issues.

The steps above may sound rather simple; however, it takes a major effort to determine all the pieces of any multi-Service operation and how they interact. This is the key to determining everything else that is necessary for training (i.e., scenarios, control mechanisms, performance measurement, AARs, etc.).

2.4 Functional Requirements

2.4.1 Scenario and Mission Design

Recommendations: How to get started on scenario and mission design:

- Describe the strategic setting for combat operations and specify the enemy and friendly forces. Work from the training objectives.

- Involve commanders, trainers, O/Cs, and engineers as early as possible. This reduces the need to revise scenario materials and decisions as each separate group reviews them.

- Select missions or mission slices and unit composition needed to satisfy training objectives. Decide which unit elements should use simulators and which should be simulated by SAFOR.

Number	Title
1	Determine battalion mission intent and concept of operation
2	Determine the enemy situation
3	Develop CAS target priorities
4	Develop priority of intelligence collection assets to detect CAS targets
5	Integrate CAS and other fire support elements with maneuver actions
6	Institute fire support control/coordination measures
7	Initiate airspace coordination areas (ACAs)
8	Incorporate SEAD in the fire plan
9	Protect laser team
10	Prepare a decision synchronization matrix
11	Establish methods to identify targets during CAS operations
12	Establish methods to identify friendly troops during CAS operations
13	Conduct a fire support/CAS rehearsal
14	Pass preplanned CAS targets to higher headquarters
15	Prioritize all CAS requests from subordinate commanders
16	Pass immediate targets and on-call target updates to higher headquarters
17	Provide initial brief to pilots and controllers
18	Update airborne pilots as necessary
19	Perform communications check among all fire support and CAS participants
20	Control CAS air attack
21	Confirm status of friendly air defense
22	Arrive on station and establish initial communications
23	Synchronize CAS attack with other direct and indirect fires
24	Conduct CAS attack
25	Return from and assess CAS mission

Figure 2. Training Objectives

Key Players (FSO is the principal one):

• Bn/TF Fire Support Officer (FSO)	• BN//TF Staff Intelligence Officer (S-2)
• Air Liaison Officer (ALO)	
• Bn/TF Staff Operations Officer (S-3)	• Subordinate commanders
• Airborne Forward Air Controller (Air-FAC)	• CAS pilots

Conditions: Enemy air defense assets have been identified and are located in the Bn/TF area. (Normally, such assets will be mobile.)

Actions: The FSO takes the following actions that are relevant to planning for the suppression of enemy air defense (SEAD):

• FSO coordinates with the S-2 and S-3 to identify air defense assets and probable locations.

• During planning, FSO plots probable locations for suppressive indirect fires. FSO also plans for subordinate commanders to use against air defense targets of opportunity. Indirect fires must conform with ACA.

• During execution, FSO coordinates SEAD fires with the CAS delivery, such that fires impact 1 minute before the strike and continue for 1 minute after the aircraft have departed.

• FSO synchronizes timing of air attack by relaying information about SEAD through the ALO to CAS pilots and the Air-FAC.

Behavioral Outcome or Product: Enemy air defense capability is effectively suppressed. No aircraft are lost to enemy air defenses.

Reference:

• Army FM 6-20-40, *Fire Support for Brigade Operations (Heavy).*

Figure 3. Example of a Training Objective: 8. Incorporate SEAD in the fire plan.

- Obtain copies of actual operations and tasking orders from higher headquarters and adapt, as necessary. (Use of such orders adds realism and provides familiar recommendations, Standard Operating Procedures, and instructions.)

- Check each preceding step against training objectives to ensure a close match. For example, do not use a bigger mission slice or more players than necessary to meet key training objectives.

- Factor in cross-Service conditions. For example, plan concurrent training missions outside the main battle for units or unit elements waiting to participate in the main battle.

Preparation of the MDT2-CAS scenario began with the "story" of the combat operation and the delineation of the forces involved. Within that context, the defensive and offensive combat operations were described for an armored battalion task force that was part of an armor brigade attached to a Marine Expeditionary Force (as in Desert Storm). The battalion's maneuver and fires, with emphasis on CAS, were also presented in story form, giving the actions of the players as correct examples of what could occur.

From this series of stories, the scenario was refined by writing Joint Task Force, Marine Expeditionary Force, and Army Division concepts of operations and commanders' guidance. Detailed brigade operation orders were developed to confine the relative "free play" of the battalion within the technical capability of the simulation environment. Initial positions for friendly and enemy forces were selected and a series of actions to insert during play were constructed to ensure that the desired range of CAS missions for key training objectives would occur (see Appendix B).

2.4.2 Performance Assessment

Assessment Tools

Effective training requires that combat performance (process measurement) and combat outcomes (outcome measurement) be assessed. Process measures focus on what happens moment-to-moment during training; outcome measures, on the other hand, provide indicators of combat results. Such an assessment is needed to (a) diagnose performance deficiencies, (b) specify training fixes, (c) plot the learning curve across exercises for teams or groups of teams constituting larger units, and (d) provide performance feedback to training participants in order to improve subsequent performance.

The MDT2-CAS program developed multi-Service process and outcome measurement tools and methods to support the requirements stated above for a DIS environment.

For process measurement, tools were developed to assess the communication and coordination required in cross-Service planning and execution of CAS. These measures enabled O/Cs for an exercise to record whether what should have happened, did happen (see Appendix C).

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Recommendation: For process measurement, two tools are recommended: (1) Checklists allow subject-matter experts to make structured observations during performance to record what happened, and (2) judgments about communication and coordination quality allow experts to record how well performance was carried out in relation to mission requirements.

Recommendation: The process measures should be completed during training exercises and used to help prepare After-Action Reviews.

The checklist data can be used to measure overall trends for a whole exercise or for parts of the battle. In one method, the proportion of behaviors performed correctly is calculated relative to the total set of behaviors that should have been performed. This provides a global indication of performance. In the second method, groups of behaviors are divided into functionally related clusters--for example, those pertinent to a specific training objective. These clusters can then be examined separately to obtain an indication of how teams performed within the functional areas.

Judgments by experts identify strengths and weaknesses and rate teamwork on such dimensions as Communication, Coordination, Adaptability, and Situation Awareness. For example, in MDT2-CAS, Communication was divided into factors such as format, terminology, clarity, and acknowledgments. For each factor, the O/Cs provided comments highlighting critical teaching points for feedback. To track performance trends, the O/Cs also provided ratings of how well the key participants interacted with each other on each dimension. The ratings ranged from "1" (Needs Work) to "4" (Outstanding).

Recommendation: Objective measures are needed to summarize battle outcomes. Such measures include casualties by weapon system, loss exchange ratios, and amount of terrain controlled (see also Appendix D).

Recommendation: Preliminary planning for DIS-based training should include coordination with a training measurement specialist. Determine the information and displays needed to conduct effective AARs.

For measuring combat outcomes, the MDT2 program modified and used the computer-based Unit Performance Assessment System (UPAS)[6]. This system, implemented on a personal computer, stores and displays information (from the DIS network) about engagements, casualties, and movement of simulated vehicles. It supports animated replays of movement and firing events, data summary graphs and tables, a timeline of exercise movement and firing events, a battle flow tracing movement of individual vehicle simulators, and a "firefight display" summarizing direct and indirect fire impact and firing vector data. The UPAS integrates network data with terrain data and unit planning data (e.g., control measures) to provide a more meaningful description of events than can be provided by network data alone.

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[6] Meliza, L.L., Bessemer, D.W., and Tan, S.C. (1994). Unit Performance Assessment System (UPAS) Development. *US Army Research Institute Technical Report 1008.*

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For MDT2-CAS, outcome measures for missions were stated in terms of the number of enemy vehicles damaged or destroyed, the number of bombs released, and the number of releases resulting in a miss. These data were developed for the entire exercise and for each CAS mission within the exercise. In addition, two types of data displays were used to provide information on synchronization of fires. The first was a graph showing volume of fires by ammunition type, and the second was a map display showing the locations of direct and indirect fires. Synchronization was assessed and illustrated by the volume of fires by weapon system over time.

Outcome measures need to be used with caution to prevent inaccurate conclusions about training success. In the MDT2-CAS exercises, the accuracy of outcome measures depended on how they were registered and stored by UPAS and interpreted by O/Cs. Near misses or damage to a target was particularly difficult to record. Casualty data can help to trigger discussions about performance problems or to highlight battle trends. The focus should not be on the casualty data itself in current DIS environments.

Management of Performance Assessment

Recommendation: Ensure that monitoring stations will permit O/Cs to control exercises and observe performance.

In DIS training environments, one or more O/Cs may be needed to evaluate performance at each of multiple nodes. Information must be provided to O/Cs to enable them to evaluate performance at both the site-specific (local) and DIS (global) level. The local view gives a different battle viewpoint based on each site. Each site or one central site ideally should have access to all views to develop a global perspective of the battlefield. This global perspective was not available for MDT2-CAS. However, information sharing among sites should be designed to provide sufficient and equivalent capabilities for O/Cs to meet observation requirements.

As systems are developed, information requirements for each O/C position should be analyzed. Candidate technologies that should be in place include: (a) a communication "hotline" between O/Cs during an exercise to ensure that problems are identified in timely fashion and that control of the scenario is maintained, (b) displays for ready and rapid monitoring of node status in DIS, and (c) technologies that enhance observation of multi-Service interactions such as displays which can switch between air and ground perspectives of combat.

For scenario control and observation in MDT2-CAS, O/Cs relied on displays and other interfaces developed for simulator systems designed originally for single-Service use and fewer O/Cs. O/Cs at the Fort Knox site, for example, competed for the stealth displays for perspective views and plan view situation displays They were needed to control the exercise and to measure performance.

Recommendation: To ensure that intended measurements or observations are obtained, the O/Cs' workload should be analyzed to determine whether they can handle a dual role of exercise control and performance assessment.

Individuals responsible for observation, control, and measurement functions in an exercise must ensure first and foremost that the scenario flow unfolds realistically. When their focus must shift to scenario control, for example, assessment opportunities will be lost. An assessment team should be dedicated exclusively to that task particularly in a distributed training system where scenarios unfold in a free-play fashion, or where system reliability can be suspect.

In MDT2-CAS, opportunities to measure performance were lost because of the O/Cs' high workload. For example, O/Cs were responsible both for assessing training performance and for controlling the flow of a battle using "trigger events" that focused trainees on selected objectives. It was difficult to inject trigger events such as an immediate CAS mission or modification of an existing Airspace Coordination Area (ACA) while assessing training performance.

2.4.3 Performance Feedback (Multi-Service After-Action Reviews)

The AAR provides direct feedback to trainees by personally involving them in the assessment process. AARs enable the trainees to discover what happened during the exercise as well as how and why it happened. They interact with one another and with O/Cs at all the various sites. Figure 4 shows the O/C organization used in MDT2-CAS.
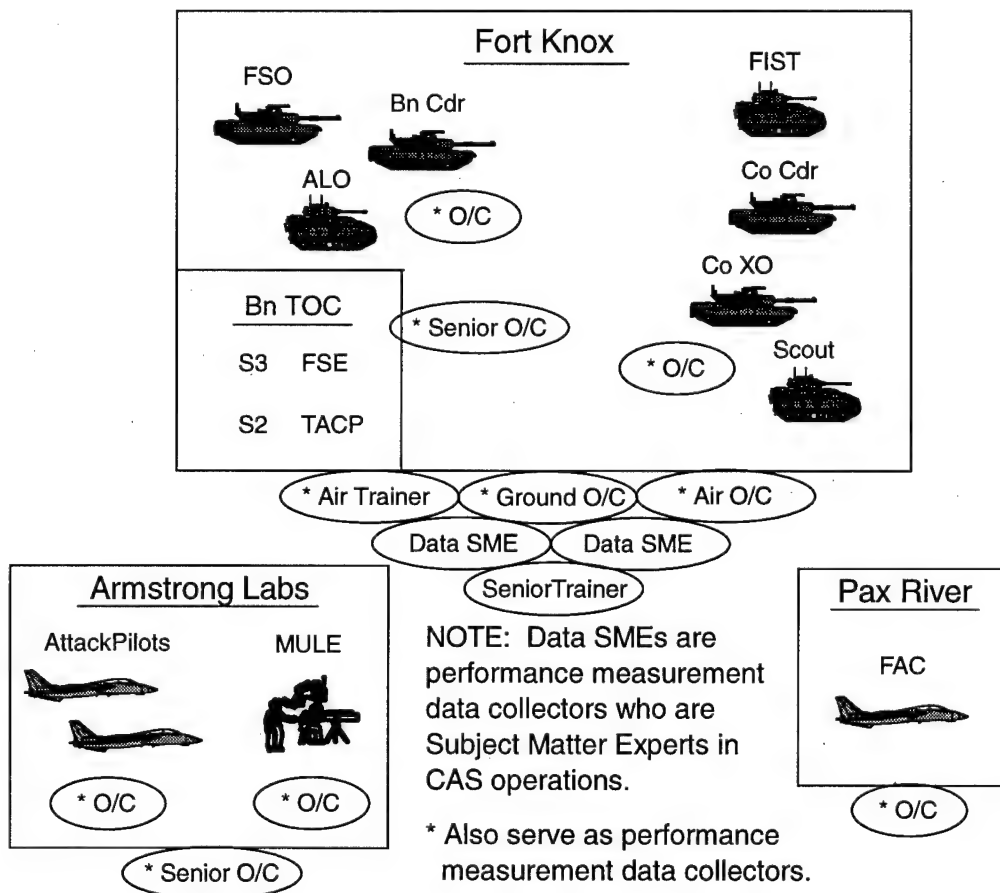

Figure 4. Observer/Controller (O/C) Organization.

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Recommendation: One person, normally the senior trainer or a senior O/C, should be in charge of the After-Action Review process. That person should coordinate the process from initial planning through development and delivery.

During the May 1994 MDT2-CAS exercises, an extremely capable senior trainer orchestrated and conducted the AARs. However, he was able to prepare for the exercise only 1 week in advance and had some difficulty maintaining focus on the "unusual" multi-Service nature of the AARs. In the February 1995 MDT2-CAS exercises, the senior trainer had developed the procedures for that AAR, and had played a major role in developing the exercise training objectives and the training scenario. As a result, the AARs were more focused on training objectives.

Recommendation: Planning for After-Action Reviews should be integrated into the exercise scenario at logical break-points, and the amount of time needed for AAR preparation should be considered in setting the schedule.

Recommendation: Rehearsal of AARs is essential to enable O/Cs to work out training points and supporting documentation.

For MDT2-CAS, the logical break-point for AARs was at the conclusion of each battle. Each AAR required about 2 hours of preparation to (a) collect feedback comments from the O/Cs at each site, (b) consolidate these comments into major teaching points, (c) work out the means to best display those points, using audio and video-teleconference, and (d) conduct a quick rehearsal of the AAR. The AAR, therefore, was conducted 2 hours after each battle.

During rehearsals, the O/Cs should consolidate comments as they would for an actual exercise and orchestrate which teaching points to draw out of the trainees, and how and in what order to best display those points. Rehearsals before an exercise can be accomplished by replaying data logger tapes from a previous exercise or by having SAFOR operators run through the exercise scenario while controlling not only enemy forces but also the elements to be played by the trainees during the actual exercise. Site O/Cs should look for key teaching points to be made and, after the mock battle, should provide comments to the senior trainer. A final rehearsal should be held with the following personnel present: the exercise director, senior trainer, site O/Cs, SAFOR operators, simulator technicians, DSINet operators, and video-teleconference (VTC) equipment operators. It is during this rehearsal that both technical and training-related problems can be discovered and corrected, and presentation methods can be refined.

Recommendation: All sites should use the lowest common communication technologies to support distributed AARs. Planning should take any limiting factors into account.

In the near term, technology is likely to be a factor limiting the feedback about multi-Service performance that can be provided to multiple sites. For MDT2-CAS, these limitations included the lack of common plan view displays as well as other performance displays, and the inability to retransmit recorded voice communications for the purpose of the

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AAR. Therefore, work-arounds were implemented in the exercise. The plan view and other performance and briefing displays were transmitted from the Fort Knox site to the other sites via a VTC system supplemented with a conference telephone call for continuous voice communications.

> **Recommendation:** **After-Action Review planning should include identifying the specific locations at each site where trainees will participate in AARs, as well as the requirements for equipment and supplies.**

Needed items such as speaker-telephones for teleconferencing among site O/Cs and VTC equipment for conduct of the AAR ought to be identified early, and the necessary networks to support those systems arranged. Video-teleconferencing, in particular, is an evolving technology with incomplete standards. Even within the same product line, different units may be incompatible with one another--as discovered for MDT2-CAS.

> **Recommendation:** **Methods for displaying After-Action Review information should be planned in detail.**

DIS technology enables a variety of options for effective displays. For MDT2-CAS, the following five methods were used: (a) The Unit Performance Assessment System (UPAS), discussed earlier, provided overall outcome information in the form of graphs, charts, and map displays. (b) Harvard Graphics^{TM} charts[7] (or other graphics) were used to display teaching points and data. (c) The Plan View Display (PVD), which shows a two-dimensional situation map including weapons' effects over time, showed replays of portions of the battle at normal speed, 3-times speed, and 6-times speed. (d) The Stealth View, which displays a three-dimensional perspective of the battlefield from any viewpoint, was replayed to reinforce the information provided on the PVD.[8] (e) Digital voice replay which allows trainees to hear communications of various elements at key points during the battle. This voice replay was run concurrently with a PVD or Stealth View replay for added emphasis.

Which display method to use and when to use it should be determined during preplanning. Selection should be based on anticipated teaching points for key training objectives. The methods used should highlight those points in a clear, understandable manner that elicits discussion from the trainees.

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[7] The use of brand names or trade marks is for accurate documentation and does not constitute endorsement by the Department of Defense or its Military Departments.

[8] Airspace for combat flights extended beyond the limits of the PVD and Stealth display used by the O/Cs with ground forces at Fort Knox. Feedback therefore was limited to this smaller air space with integrated views of air and ground operations.

Recommendation: At the conclusion of each After-Action Review, senior trainers and site O/Cs should conduct a post-AAR critique (an AAR of the AAR). The focus should be on what went well, what did not, and what to change or refine for the next AAR. Comments from any participant should be solicited.

Multi-Service distributed AARs are not yet well developed and institutionalized so that critiques are essential for improvement.

2.4.4 Component or Service-Specific Debriefs

Recommendation: In addition to the multi-Service AAR, provisions should be made for component or Service-specific debriefs. These debriefs allow the detailed review of TTPs that are not of interest to everyone but are critical to specific team and crew performance.

Inter-Service coordination and communication skills must be based on a solid foundation of individual and Service-specific skills. Debriefs about these latter skills ensure that individuals can gain the most benefit when they train with other Services. Local sites should use the best and most appropriate technologies and displays available since compatibility with others is unnecessary. An added benefit of such debriefs results if they are scheduled for periods that otherwise would be time spent waiting for the exercise to continue.

Recommendation: To ensure maximum benefit from the use of simulator resources, concurrent training should be planned for participants when they are not involved in the DIS exercise.

When not tasked for MDT2-CAS, the F-16 pilots and DFO/MULE team used their simulator systems for other training tasks such as precision-guided munitions delivery under the direction of a site O/C who debriefed them on how they performed. Likewise, the ground force was debriefed on any fires and maneuvers conducted separately from CAS.

3.0 TRAINING EXERCISE PREPARATION AND EXECUTION

3.1 Training Environment and Force Structure

Recommendations:

- Ensure sufficient correlation of terrain databases for all simulators and simulations. Arrange engineering fixes to translate inconsistencies in various separate simulator databases.

- Identify simulator limitations and adjust scenarios or exercise management as "workarounds." Key limitations include the number of vehicles that can be simulated and the visibility range.

- **Plan alternatives for use if network connections are interrupted. For example, designate O/C personnel to play roles at sites that "fall off the net" in order to continue training at remaining sites.**

For the MDT2-CAS terrain database, the National Training Center (NTC) at Fort Irwin, CA was chosen because it could be used by simulators at all sites. It also allows for future comparison with actual NTC field exercises, and for possible use in combining MDT2 exercises with live force-on-force exercises.

The technical restrictions associated with various simulators had considerable effect on the planning. For example, the simulators in MDT2-CAS could not all display the same number of entities such as enemy and friendly vehicles and weapons effects in the same battle space. Scenarios and missions had to be constructed so that the number of entities coming into the fields of view of those simulators did not exceed their limitations (also see the following Section).

Simulator connectivity among the networked sites improved greatly from the beginning to the end of the MDT2-CAS program. O/C personnel at Fort Knox used voice communications, stealth displays, and SAFOR to emulate other sites when one or more were disconnected. These workarounds were acceptable although the net effect was reduced multi-Service training.

3.2 Simulation and Simulator Environment

MDT2 has the potential for training multi-Service tasks involving planning and execution at the tactical level. It clearly demonstrates the significant progress made by the DIS community in developing standards for compliance, compatibility, and interoperability of simulators. However, simulation still cannot provide unconstrained training of all mission-related tasks. These technology limitations must be considered when defining the possible range of training objectives and mission scenarios. Appendix E contains a description of simulators used in MDT2-CAS.

In the typical DIS exercise, a number of existing simulators are linked. Because these simulators were built to meet different requirements, they differ in architectures, displays, image generators, databases, and processing capabilities. In addition, DIS protocols are not yet able to transmit the full complexity of the combat environment between simulators. Consequently, the virtual worlds produced within different simulators in a DIS exercise may not be identical for historical and technological reasons rather than for operational reasons.

3.2.1 Interoperability of Simulators

The major technical challenge in implementing an exercise with current DIS technology is to ensure that the trainees using different weapon system simulators can interact with one another as part of the same battle. Interoperability is a fundamental problem in designing and implementing a DIS exercise. It is encountered whenever different simulators must interact with one another as members of the same virtual environment. Their representations of that environment must be sufficiently correlated with one another to provide the appropriate stimuli, responses, and feedback necessary for training.

**Recommendation: The capability of each simulator and the degree of
interoperability among them should be determined.**

Trainers, engineers, and SMEs must work together to determine technical capabilities
(and limitations) for interoperability. Engineers must define simulator capabilities for the
conditions under which the simulators will be used and the degree of interactivity that is expected
among the various sites. Similarly, trainers can fully define the training objectives, mission
scenarios, and data requirements only on the basis of the capabilities of the specific simulators
and support systems. To facilitate this blending process, trainers need to provide the engineers
with a broad overview of the training objectives, the mission that will be simulated, a
prototypical scenario, and data requirements. This information enables the engineers to
understand what the simulation must do. They then can describe to the trainers and SMEs the
capabilities and limitations of each simulator from the perspective of the particular exercise.

For MDT2-CAS, the principal source of interoperability problems involved the
appearance of the battlefield in the different simulators. In the real world, the appearance of the
battlefield depends primarily on a weapons system's position and sensors. For example, soldiers
in a tank cannot see as far as pilots flying 10,000 feet above ground-level. Although theoretically
both the soldiers and the pilots have the same information available to them, their ability to
detect and use this information differs because of their location on the battlefield. In contrast,
different simulators in MDT2-CAS introduced artifacts into the battlefield's appearance because
of differences in the fidelity of terrain representation, and the characteristics of the various
simulators. Consequently, in MDT2-CAS, the appearance of the battlefield depended not only
on the weapon system being simulated and its simulated location on the battlefield, but also on
the simulator itself.

**Recommendation: Technical fixes should be used to achieve sufficiently
correlated terrain databases.**

Given the current state-of-the-art in simulation, the appearance of the same terrain in
different simulators is likely to differ. These differences must be identified and minimized if
different simulators are to share a realistic common virtual world. Correlation tests should be run
from selected coordinates during preparation for an exercise. Elevation and intervisibility data
should be recorded and appropriate database or scenario modifications initiated.

Since terrain databases are developed specifically for each simulation system, there
usually will be differences in the degree of terrain resolution. This creates a lack of correlation
between terrain databases in the different simulators. A result of this limited correlation is that
ground vehicles can be positioned above ground in one simulator and below ground in another
simulator. In MDT2, this problem was reduced by using a technical fix known as "ground
clamping." This fix allowed the receiving simulator to position the entity at a ground elevation
consistent with its local terrain elevation data. It also kept marking rounds and bombs from
detonating underground.

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Although ground clamping works fairly well for ground vehicles, it does not solve all the problems associated with mismatches in terrain elevation. They may still cause errors in line of sight and may cause aircraft to "fly through hills" when viewed from ground vehicles. Therefore, in addition to "ground clamping," extensive testing needs to be done to ensure that the performance of the participants and their weapon systems will not be compromised.

MDT2-CAS used terrain databases representing the NTC with different implementations depending on a site's simulator capabilities and requirements for the exercise. The aircraft simulators in Mesa, AZ and Patuxent River, MD used the same terrain database; the DFO/MULE (laser designator) used highly detailed elevation data overlaid with geo-specific photographs taken at the NTC. The MWTB at Fort Knox had still another database for SIMNET vehicles. At times during the course of an exercise, the elevation data were not properly matched. Tests comparing selected coordinates across sites were done during exercise preparations to achieve the best terrain correlation possible.

> **Recommendation:** **Technical fixes should be used to accommodate differences among simulators in displaying moving vehicles and weapons effects.**

Differences in the number of moving vehicles and weapons effects that can be displayed to trainees in the various simulators have significant impacts on the design of scenarios and the conduct of training. Scenarios have to be carefully tailored to ensure that each trainee is able to respond appropriately as the battle unfolds.

MDT2-CAS managed simulator differences to display moving vehicles and weapons effects by using scenarios with limits on what was needed for realistic combat. While the armor simulators at the MWTB had an essentially unlimited ability to process and display moving vehicles and weapon effects, all the other simulators had much more limited capabilities. The aircraft simulators at Mesa, AZ and Patuxent River, MD were modified to be capable of processing and displaying a total of 54 and 16 moving vehicles and weapon effects, respectively. The DFO/MULE, however, could not be modified, within available resources, to see more than five moving vehicles. Scenario action was designed to accommodate the simulators.

> **Recommendation:** **Compatible representations of the virtual world among sites should be developed by testing how different protocol translators and Network Interface Units (NIUs) handle and represent DIS Protocol Data Units (PDUs).**

Differences in how the various sites handle DIS PDUs affect both the simulation and the information available to trainers and engineers. During MDT2-CAS, scenarios and training had to accommodate differences. For example, the site configuration at Patuxent River, MD for the Air-FAC did not process fire and detonate information from 23mm rounds fired by the ZSU-23/4 at the MWTB. The Air-FAC, therefore, had to be immune from engagement by that ground threat. Another technical difference among sites was that the DIS laser PDU was not translated to the protocol format at the MWTB. O/Cs at the MWTB could not determine which vehicles were being lased and were not able to use that tactical information for training except through verbal reports from other sites.

3.2.2 Exercise Environment

Recommendation: **The training objectives and mission scenarios should be reviewed in terms of simulator capabilities.**

Once the desired exercise requirements and technical capabilities have been defined, it is necessary to determine whether the simulation can support the training objectives and mission scenarios. This represents a continuation of the interactive exchange of information among trainers, engineers, and SMEs. If the simulation cannot fully support the training objectives and mission scenarios, decisions must be made regarding the importance of the various technical shortcomings and possible solutions. Solutions range from modifying the training objectives or mission scenarios to making engineering changes to one or more of the simulation systems within time and budget constraints.

Recommendation: **A communication plan should be developed covering all types of intersite communications.**

Information must be transmitted between DIS sites to support network operations, exercise control, tactical operations, and After-Action Reviews. The need to provide such a wide variety of information imposes a number of communication requirements on both the wide area network (WAN) and its attached local area networks (LANs). These requirements include identifying what communications must be provided between which sites and which participants; estimating bandwidth; selecting and allocating communications media; defining and implementing the various communication links; and establishing operating procedures.

Recommendation: **For geographically-distributed exercises, time references should be established and all participants informed what they are.**

Time references in a DIS exercise may refer to simulated time, local time at a given site (e.g., 1000 MST), local time at another site (e.g., 1200 EST), or a standard time such as universal coordinated time (e.g., 1700 GMT). Confusion is particularly likely to occur when administrative and exercise times are different.

3.3 Exercise Management

3.3.1 Scheduling and Preparation

Scheduling a DIS training exercise is similar to scheduling a field training exercise (FTX). In both cases, schedules of trainees and O/C personnel must be coordinated and deconflicted. For an FTX, training areas, vehicle/aircraft/equipment use, and supporting fuel, munitions, and other logistics must be coordinated and deconflicted. A DIS exercise involves a similar set of scheduling and logistical activities.

Recommendation: **A program schedule should be developed after the training requirements are finalized.**

Recommendation: The availability of simulations and simulators, communication networks (e.g., Defense Simulation Internet or DSINet), and supporting resources must be coordinated and deconflicted with competing demands.

Trainee participation with DIS must be integrated with different Services' master training schedules as far ahead of the scheduled training exercise as possible. There generally is no schedule for multi-Service exercises using DIS facilities, so planning is particularly challenging for major units such as battalions, brigades, squadrons, and wings.

Recommendation: Special attention needs to be given to developing an exercise schedule when different time zones are involved.

A major problem in scheduling a DIS training exercise is that it may span several time zones. Planners must consider these time differences in developing exercise schedules. Time differences can have an impact on all participants. For example, are the planned times acceptable, given contractual requirements such as the scheduled periods of operation and maintenance for simulation and networking facilities? It is very easy to forget that an exercise scheduled to kick off on the East Coast at 0900 EST may actually require personnel on the West Coast to begin working at 0400 PST.

3.3.2 Security Requirements

Recommendation: Security needs must be considered when scheduling DIS training exercises.

An exercise and all participating sites may be classified even if only one site on the network handles secure data. This may require upgrading site and participant security clearances. Depending on the clearance level required, it could take 2-8 months or more to obtain clearances for all the participants. The MDT2-CAS training exercise required SECRET NOFORN for each site and participant; obtaining the necessary clearances took approximately 2 months. Had it required clearances necessitating a complete background investigation, 6-8 months would have been an optimistic forecast. Check with network security officials to insure necessary lead times when making initial exercise plans.

3.3.3 System Testing, Rehearsals, and Participant Pretraining

Recommendation: Functional verifications of the environment should be conducted to confirm system capabilities.

Component and system testing must be conducted as necessary to verify individual simulator performance, compliance with DIS standards, simulator interoperability, and compatibility with mission scenarios. In addition, stress testing should be performed to verify system performance under exercise loads. Sufficient time must be scheduled between tests to allow engineering and scenario modifications to be made.

For MDT2-CAS, the test program used a building block approach. DIS compliance and simulator interoperability were established for small numbers of simulators and SAFOR forces located at agreed upon test points. Once the operation of each simulator was verified, the scope of the testing was expanded to include mission scenarios. The tests did not thoroughly stress the system because the availability of troops and facilities was limited.

> **Recommendation:** **In addition to the necessary technical and engineering testing/ rehearsing, time must be scheduled for the non-trainee participants to conduct rehearsals of the training scenarios and variables.**

During rehearsal, a full load should be placed on the network so that problems can be identified and resolved prior to the actual exercise. Scenario events that will strain the capabilities of certain simulators need to be rehearsed and changed if necessary to stay within those limitations. For the MDT2-CAS exercise, this meant repositioning simulator start points and rearranging the flow of enemy forces into those simulators' fields of view. Additionally, O/Cs and support personnel must rehearse their orchestration of AARs (discussed in Section 2.4.3).

> **Recommendation:** **A permanent team of qualified personnel for multi-Service DIS exercises is desirable to consistently perform O/C tasks.**

Of central importance to any training exercise are the O/Cs who control the exercise, play the roles of higher headquarters, manipulate the scenario to focus on key training objectives, assess trainee performance, and provide feedback through debriefs and After-Action Reviews. They must be experienced professionals and true experts in the areas to be trained. A permanent cadre would be ideal but may not be practical for geographically separate sites.

If a permanent O/C team is not available, then exercise planners should note that the required SMEs in multi-Service combat operations are scarce resources with many competing demands. They can be found in Service and Joint staffs, schools, and training centers, as well as in field units. They must be scheduled months in advance, however, because their availability limits when training is possible.

Additionally, the appropriate number of O/Cs to support reliable evaluation of trainee performance should be determined, and the levels of experience and background level should be defined for each O/C position.

> **Recommendation:** **O/Cs must receive training and familiarization on procedures to be followed to conduct the exercise and on the capabilities and limitations of simulators and systems at their own and other sites.**

> **Recommendation:** **At least 2 weeks in advance of the exercise, O/Cs should visit the training sites to review materials and plans.**

If O/Cs are not permanently assigned to simulator sites, particular emphasis should be placed on their pre-exercise training. Site visits and prebriefs are essential. The training should

ensure that the O/Cs understand their roles and those of others on the O/C team, both during and after the exercise (during AARs and debriefs), and that they are fully aware of the goals of the training exercise, the nature of the scenario, and how observation or performance measurement tools are to be used. O/Cs from each site should travel to other sites to become familiar with those sites' particular simulator/system nuances.

To the fullest extent possible, O/Cs should be involved in developing the training exercise and performance measurement approaches. If this is not possible, additional "formal" training and practice in these areas should be provided. The O/Cs must thoroughly understand the structure of the AAR, the relationship of the measurement system to the AAR, and the timing and nature of O/C inputs to support the AAR.

O/C familiarization with the strengths and weaknesses of the various simulators and the degree of interoperability among these simulators is imperative. O/Cs should particularly be trained on the facilities available to them (instructor/operator stations, network status boards, etc.) that support the observation and control of planning and combat. They need to know the administrative procedures for initiating and ending exercises and for managing exercise flow, including procedures to be implemented when nodes drop off and re-enter the exercise. They should be familiar with any site-specific issues that enhance or degrade evaluation of performance at that site.

Most importantly, O/Cs must understand the key training objectives, tasks, conditions, and standards to be trained.

> **Recommendation: After final review and adjustments, the exercise baseline and all supporting personnel and functions should be "frozen."**

The training environment--the training objectives, scenarios, simulations, simulators, assessment tools, facilities, and all personnel--should be reviewed and checked to verify that it can do the job. After any final adjustments, the environment should be frozen to avoid changes that compromise training execution as designed.

3.3.4 Trainee Preparation

> **Recommendation: At least 1 month in advance, trainees should be provided with materials on the tactical situation, combat intelligence, and the necessary operations orders for the exercise.**

> **Recommendation: On Day 1 of the rotation, the trainees should be briefed and familiarized with the simulator operations. Do not begin the exercise on Day 1.**

Preparation of trainees should begin about a month before the exercise. Provide the participating units with sufficient materials so they can do rehearsals of the anticipated missions. At a minimum, supply them with a description of the tactical situations and higher order operation orders.

In preparing for training, the key objectives, mission, exercise scenario, enemy characteristics, and resources available should be described to the trainees. Trainees need to understand the task requirements for performance at their simulator and site, and the roles/tasks of other participants with whom they may interact. Key, service-specific language should be explained.

In addition, it is critical to tell the trainees how simulator and networking limitations will affect play of the missions and trainee participation. Trainees will benefit more from the rotation if they start with realistic expectations. Time should be allowed on Day 1 for trainees to become familiar with their simulators and with the differences between the simulator and the actual equipment. A written checklist of features to be explained should be developed. MDT2-CAS trainees reported that they were not prepared to begin mission training exercises on the first day.

4.0 ARCHIVE EXERCISE

4.1 Archive Baseline

> **Recommendation: The exercise baseline should be preserved as a reference for repeating it, reviewing it, or using it as a model for developing other distributed training.**

The baseline record of an exercise should include training objectives, scenarios, hardware configurations, software loads, network configurations and loads, measurement tools, and all participant and trainee requirements.

4.2 Archive Performance Data

> **Recommendation: AARs and electronic records should be maintained to aid in deriving "lessons learned" from multi-Service training.**

Standard items, such as operations orders and planning documents, should be retained in the archive. In addition, it should include recordings--which are possible using DIS technology and video cassettes -- of (a) the combat and communication portions of the exercise and (b) multi-Service AARs. Finally, the archive should contain summaries of performance assessments.

5.0 POST-EXERCISE TRAINING REVIEW

5.1 Purpose of After-Training Review (ATR)

> **Recommendation: At the end of all exercises, an After-Training Review (ATR) should be conducted to answer the following major questions:**

(1) **Did the training add value to the multi-Service training pipeline and meet the needs of all participating troops?**

This question is to routinely assure training quality control. It is a "temperature" check, a "first-aid" diagnosis of DIS training system value and problems. It has five dimensions: need for the training multi-Service DIS can provide, credibility of the simulation, multi-Service value, role in the training cycle, and the expected impact of the training.

(2) **Did the training program work as expected? If not, what needs to be fixed, added, or eliminated?**

This question can be asked in many ways. One way is to ask how well the training objectives for the exercises were implemented. To what extent did the training satisfy those objectives? Critical or negative answers can point to limitations in simulator capability or deficiencies in scenario design.

(3) **How useful were the training and evaluation tools and methods, such as orientations, exercise design, AAR methods?**

The MDT2 approach emphasizes training tools and methods to support front-end preparation, exercise conduct, and AAR for multi-Service training. The usefulness of these methods needs to be monitored so that they can be improved.

Results of an ATR can assist the participating units in planning follow-up training and future use of DIS. Longer range, the ATR data can be archived and used for on-going quality control of DIS training. For example, the ATR can document the need for training program upgrades or more limited changes in planning and managing subsequent DIS rotations.

5.2 Getting Started

5.2.1 Planning an ATR

Recommendations: **The following procedures should be used in planning an After-Training Review:**

- **Incorporate ATR surveys and interviews into plans for scheduled DIS exercises.**

- **Include an ATR specialist as part of the team for planning DIS rotations.**
- **Include ATR results as part of the archival information.**

These recommendations make the ATR an integral part of an exercise. Planning should start early and be part of the baseline plan outlined in Section 2.1. For an operational training system, the ATR methodology should provide "lessons learned" to archive for others to use. Recommendations based on MDT2-CAS are oriented more toward prototype work.

5.2.2 Conducting an ATR

Recommendation: Collect biographical information from each player.

Biographical data summarize a trainee's military background and experience including any cross-training. Data forms should be tailored to the different training sites and Services. The primary purpose of biographical information is to help organize the rest of the ATR. Commanders also can use biographical data for planning future training and assisting career development.

Recommendation: Use a short, training-value questionnaire.

This questionnaire provides trainees and O/Cs a structured method to record whether or not their training needs were met along with why or why not. It should be given after some training in the simulator environment. For MDT2-CAS, the questionnaire was used after at least two simulated battles were fought and AARs completed. The results are useful to stimulate discussion "back home" about plans for future training.

Recommendation: Administer a questionnaire on how well training objectives were satisfied.

Judgments by participants are made about how well the simulation network and mission scenarios satisfy the training objectives. O/Cs and commanders should select the highest priority and challenging objectives for a manageable and focused assessment. MDT2-CAS emphasized 7 out of 25 objectives.

Recommendation: Conduct group debriefings to obtain more detailed information about what worked, and what did not work in the training.

After training ends, participants at each site should be debriefed to (a) check whether significant training needs were or were not met, (b) identify problems, and (c) recommend ways to improve the training experience. More detailed recommendations based on initial applications of MDT2-CAS training are provided in Appendix F. They are intended as models, or templates, not prescriptions.

5.3 Users of and Uses for ATR Data

Recommendation: After-Training Review data should be collected and saved for multiple users of results, including unit commanders, training managers, and military and political leadership. The data also should be forwarded to the Modeling and Simulation Resource Repository.

Unit commanders can use ATR results to communicate with subordinates about training needs. They also can use the data to determine the role of simulation in the unit's training cycle.

Training managers would have, in the ATR data, a reference source of information for planning and running future exercises. A production version of MDT2-CAS would be served best by a well-trained and experienced cadre for multi-Service training. They would be responsible for adjusting, revising, and updating training methods and tools, and also for identifying improved ways to translate training objectives into simulation exercises.

The military and civilian leadership will need continuing, documented evidence of the value of DIS-type training if it is to be supported at the levels for which this type of training inherently needs to become institutionalized. Training program review data support that purpose.

6.0 SUMMATION: PLANNING AND CONDUCTING A DIS EXERCISE

Following is an outline, in abbreviated terms, of the various steps recommended by the MDT2 development team to be taken, from inception to final assessment, in planning and conducting a DIS training exercise:

- Review when to use DIS environment for tactical training

- Assign responsibilities

- Schedule:

    Participants
    Sites
    Network
    Observer/Controllers (O/Cs)

- Identify:

    Training objectives
        Who is being trained to do what?
        What are the training objectives and tasks?
        Keep these in mind throughout design, implementation, and conduct
          of the exercise

    Functional requirements

    Scenarios and mission

    Assessment metrics: Measures of effectiveness/Measures of performance
      (MOE/MOP)

    Feedback/After Action Review for multi-Service
        Requirements
            Who gets what feedback and when?
            How will feedback be given?
        Service-specific debriefs

    Exercise preparation and execution
        Force structure and environment
            Manned
            Computer generated

Synthetic environment
Terrain database
Time of year/Time of day
Special conditions (e.g., weather)
Simulated entities (weapon systems, C2 nodes, etc.)

Exercise management requirements
Security
Network status
Mission initialization
Real-time control
Mission planning
After-Action Review requirements

Communication requirements
Mission execution
Tactical networks
Command and control networks
Technical monitoring
Simulation
Network
Exercise control
Mission planning
After-Action Review
DIS PDU requirements
Mission execution
MOE/MOP
Exercise control
Mission planning
After-Action Review requirements
Bandwidth required
Network organization

- Review site capabilities:

  Modify requirements
  Enhance site capabilities

- Freeze requirements

- Develop program schedule:

  Development
  Functional verification
  Exercise conduct

- Conduct site-specific enhancements

- Verify site readiness

- Conduct functional verification:

  Entity performance
  Weapon effects

Terrain registration
                    Line of sight
                    Communications
                            Mission execution
                                    Tactical networks
                                    Command and control networks
                            Technical monitoring
                                    Simulation
                                    Network
                            Exercise control
                            Mission planning
                            After-Action Review
            Data logging
            MOE/MOP

- Finalize exercise:

        Schedule
        Scenario
        Resources

- Freeze exercise baseline

- Publish supporting materials (e.g., order of battle, operations orders, simulator limitations)

- Pretrain and rehearse participants

- Finalize administrative and logistical details

- Conduct exercise

- Archive exercise baseline and exercise data

- Review and document exercise lessons learned

LIST OF ABBREVIATIONS AND ACRONYMS

AAR	After Action Review
ACA	Airspace Coordination Areas
AGOS	Air-Ground Operations School
AL/HRA	Armstrong Laboratory/Aircrew Training Resources Division
ALO	Air Liaison Officer
ALSA	Air, Land, Sea Application Center
ARI	U.S. Army Research Institute for the Behavioral and Social Sciences
ATR	After Training Review
BN	Battalion
CAS	Close Air Support
Cdr	Commander
Co	Company
DDR&E	Director Defense Research and Engineering
DFO/MULE	Deployed Forward Observer/Modular Universal Laser Equipment
DIS	Distributed Interactive Simulation
DMDC	Defense Manpower Data Center
DMSO	Defense Modeling and Simulation Office
DSInet	Defense Simulation Internet
EDT	Eastern Standard Time
FAC	Forward Air Controller
FSE	Fire Support Element
FSO	Fire Support Officer
FTX	Field Training Exercise
GMT	Greenwich Mean Time
IDA	Institute for Defense Analyses
MCCDC	Marine Corps Combat Development Command
MDT2	Multi-Service Distributed Training Testbed
MOE	Measure of Effectiveness
MOP	Measure of Performance
MST	Mountain Standard Time
MWTB	Mounted Warfare Test Bed
NAWCAD	Naval Air Warfare Center Aircraft Division
NAWCTSD	Naval Air Warfare Center Training Systems Division
NIU	Network Interface Unit
NTC	National Training Center
O/C	Observer/Controller
OUSD	Office of the Undersecretary of Defense
PDU	Protocol Data Unit
PST	Pacific Standard Time
PVD	Plan View Display
S-2	Staff Intelligence Officer
S-3	Staff Operations Officer
SAFOR	Semiautomated Forces
SEAD	Suppression of Enemy Air Defense
SIMNET	SIMulator NETworking
SME	Subject Matter Expert
TAC-A	Tactical Air Controller - Airborne
TACP	Tactical Air Control Party
TF	Task Force
TOC	Tactical Operations Center
TTP	Tactics, Techniques, and Procedures
UPAS	Unit Performance Assessment System
VTC	Video-Teleconference
XO	Executive Officer